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Hjortkjær, Jens

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The Shape of Sounds: Audiovisual integration of visual shapes and musical sounds in the human brain

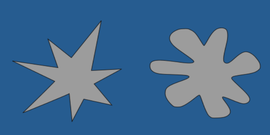
Yuko Kasashima-Shindo[1,4], Jens Hjortkjær[1,2], Tanja Kassuba[3], Keiichiro Shindo[1,4] , Hartwig Siebner[1]

1 Danish Research Centre for Magnetic Resonance (DRCMR), Hvidovre Hospital, Hvidovre, Denmark
2 Oticon Centre of Excellence for Hearing and Speech Sciences, Technical University of Denmark, DTU Electrical Engineering, Lyngby, Denmark
3 Princeton Neuroscience Institute , Princeton University, NJ, USA
4 Department of Rehabilitation Medicine, School of Medicine,Keio University, Tokyo, Japan

Mail to: yuko.shindo33@drcmr.dk, jhjort@elektro.dtu.dk

Introduction

Humans spontaneously perceive sounds in terms of abstract shape properties. One sound may be heard as 'round' and another as 'sharp'. Such 'sound symbolism' is illustrated in the so-called 'Kiki-Bouba-effect'[(1)]:

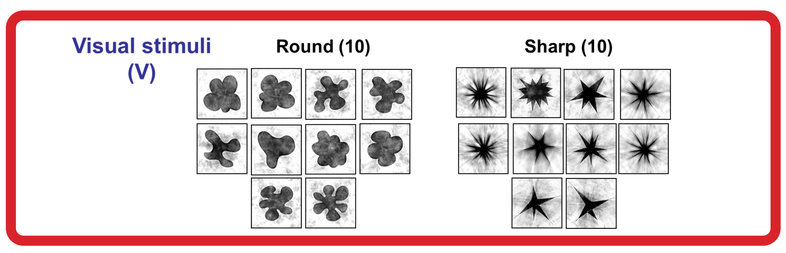
'Kiki'  **'Bouba'**

What are the neural correlates of these 'synesthesia-like' mappings of shape between vision and sound in the normal brain?

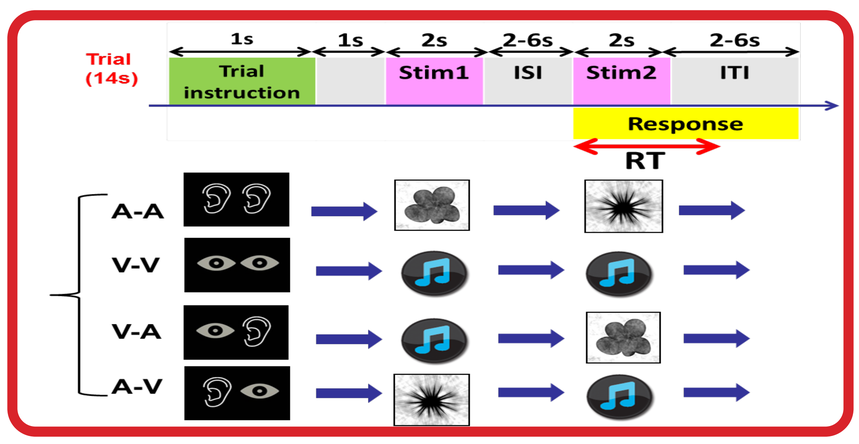
Methods

Participants:
24 healthy adults (23 ± 4.1 y.o. (18-35), right-handed)

Stimuli
Visual stimuli consisted of abstract rounded or spiky 2D figures matched with respect to their global spectral properties. Electronic musicians created sounds (2s) to match the 'shape' of the images.



Event-related fMRI exprimental paradigm
Two stimuli (S1-S2) were presented sequentially in each trial. Stimuli were either auditory (A) or visual (V), and either congruent (c) or incongruent (i) yielding 8 conditions (AAc, AAi, VVc, VVi, VAc, VAi, AVc, AVi).



fMRI aquisition:
Fast gradient echo EPI squence, TR=2490ms, TE=30ms, 42 axial slices (FOV 192mm , 3 x 3 x 3 mm^3), whole-brain coverage

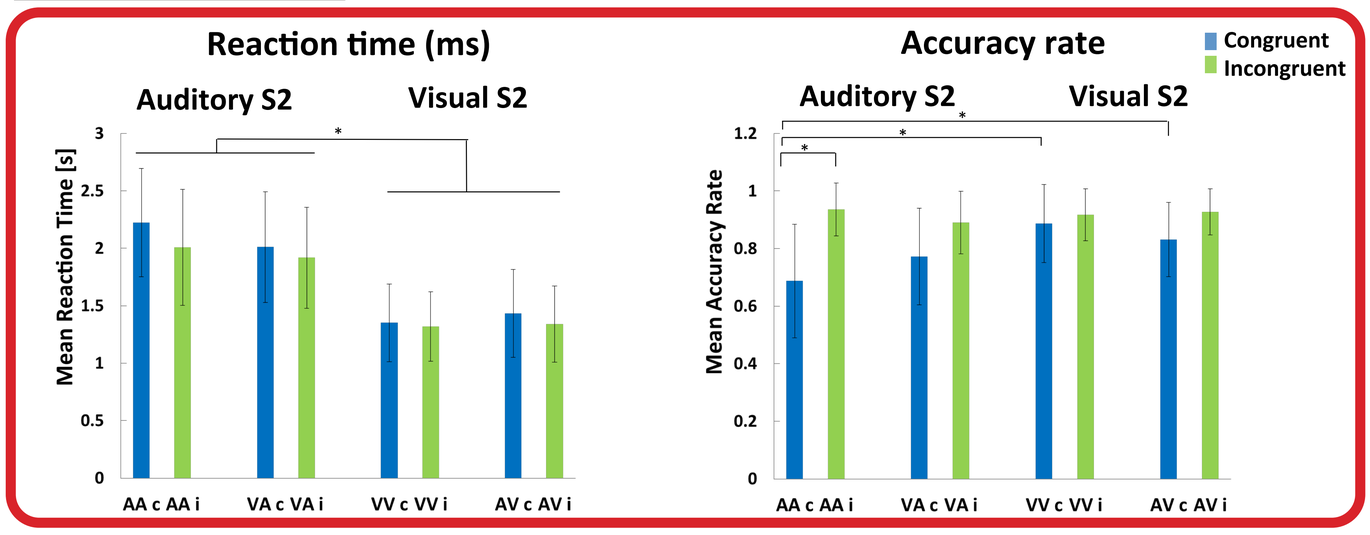
Data analysis
Behavioral data: 3-way repeated-measures ANOVA and Turkey's HSD post-hoc test.

fMRI: general linear model with separate regressors for S1 and S2 within each trial condition. Group level: factorial 2x2x2 model with factors S2-Modality x Congruency x Sensory-Mathing.

Results

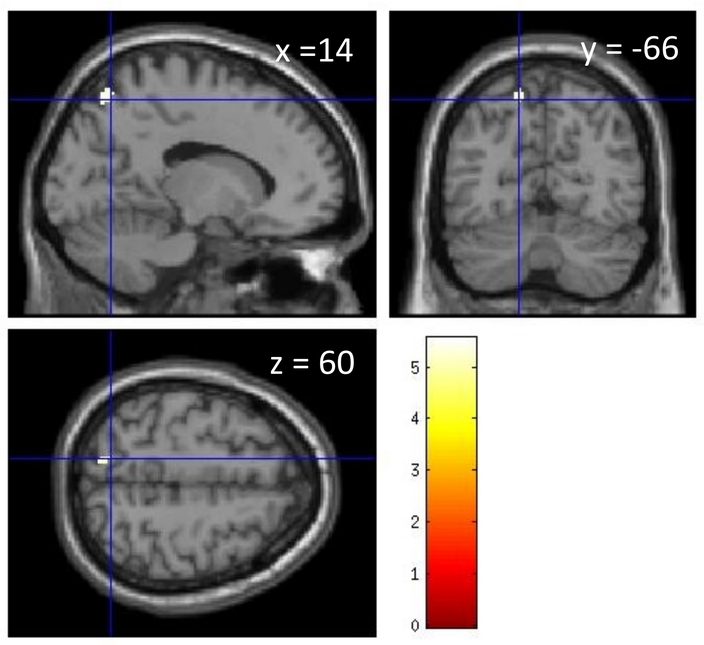
Task performance

*Tukey's HSD post-hoc test $P< 0.01$



fMRI

[(VA c+AV c)>(AA c+VVc)]>[(VA i+VA i)>(AA i+VV i)]



Increased activity in the medial part of the left posterior superior parietal lobe (pSPL) for congruent shapes when these are matched across visual and auditory modality. Activity related to the incongruency of shape information was observed in the right superior and inferior frontal gyri (SFG/ IFG) and in left inferior parietal lobe (IPL).

Figure 1: Effect of the interaction Sensory-Matching by Congruency (congruent > incongruent x bimodal > unimodal) (FWE $P<0.05$)

Discussion

- Increased left-lateralized activation of pSPL in bimodal relative to unimodal matching for congruent opposed to incongruent stimulus pairs.
- SPL is known to be involved in switching attention between auditory and visual information[(2)], and in attending to visual shapes[(3)]. Our results suggest that the posterior part of SPL may be involved in binding abstract shape information across modalities.

Conclusion

Posterior SPL plays a role in audio-visual integration of abstract visual shapes and musical sounds

References

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